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FUSION SPLICING DEVICE FOR OPTICAL FIBERS

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FUSION SPLICING DEVICE FOR OPTICAL FIBERS

[Hikari fuaiba no yuchaku sochi]

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Claim

A type of fusion splicing device for optical fibers characterized by the fact that it has a holding part that holds the two optical fiber to be spliced by means of magnetic force, and it has a pair of optical fiber holders that can adjust the relative three-dimensional positions of the end portions of said optical fibers.

Detailed explanation of the invention

The present invention pertains to a type of fusion splicing device for optical fibers for fusion splicing of the end surfaces of two optical fibers used for optical information transmission means or the like.

In the portable fusion splicing device of optical fibers in the prior art, in order to splice optical fibers, the optical fibers are peeled out in an appropriate length, and the end surfaces of the two optical fibers are shaped and set facing each other and in contact with each other, and they are fusion spliced by means of the heat of discharge.

However, in said device, because fixing screws or squeezing holding constitution by means of the elasticity of springs is adopted, the holding force on the optical fibers is too high, leading to breakage or other problems with the optical fibers.

The purpose of the present invention is to solve the aforementioned problems of the prior art by providing a type of fusion splicing device for optical fibers characterized by the fact that it has a holding part that holds the two optical fibers to be spliced by means of magnetic force, and it has a pair of optical fiber holders that can adjust the relative three-dimensional positions of the end portions of said optical fibers.

In the following, the fusion splicing device of the present invention will be explained in more detail with reference to application examples illustrated with figures. Figure 1 is an oblique view of the fusion splicing device of optical fibers of the present invention (hereinafter to be referred to as device of the present invention). Figure 2 is a partially cut off plan view of said device. Figure 3 is an enlarged oblique view of the holder of the optical fiber. In the figures, (1) represents a rectangular base table. As shown in Figures 1 and 2, on base table (1), left hand stage (2) and right hand stage (3) are set on the two sides of the central line for aligning the optical fibers. Above the facing portion of said two stages (2), (3), microscope (4) is set on the rear side, and stage (5) for adjustment to move a gas burner is set on the front side.

On stationary table (21) with left hand stage (2) set on base table (1), movable table (22) is set so that it can be driven to move in the left/right direction indicated by the arrow in Figure 1, that is, in the axial direction of the optical fiber. On said movable table (22), mounting member (23) with an inverted-L shape as its front view is fixed. On the upper end portion of said mounting member (23), on the side facing right hand stage (3), holder (24) is fixed for setting optical fiber  $F_1$  on one side for splicing. By manipulating movement adjusting screw (21a) set on stationary table (21), said holder (24) can be adjusted to move in the left/right direction shown in Figure 2, that is, in the axial direction of the optical fiber.

On the other hand, on stationary table (31) with right hand stage (3) set on base table (1), movable table (32) is set such that it can be driven to move in the back/forth direction indicated by the arrow in Figures 1 and 2, that is, in the horizontal direction perpendicular to the optical fiber. On said movable table (32), lift member (33) that can be driven to move in the direction perpendicular to the paper sheet in Figure 2 (in the direction indicated by arrow in Figure 1), that is, in the vertical direction perpendicular to the optical fiber, is set. On the upper portion of said lift member (33), on the side facing left hand stage (2), holder (34) is fixed for setting optical

fiber F<sub>2</sub> on the other side for splicing. By manipulating movement adjusting screw (31a) set on stationary table (31), said holder (34) can be adjusted to move in the back/forth direction shown in Figure 2 and in the vertical direction perpendicular to the paper sheet, that is, in the horizontal direction and vertical direction perpendicular to the optical fiber.

With said constitution, holders (24), (34) of left/right side stages (2), (3) with said constitution can be adjusted to move so as to make relative three-dimensional movement of optical fibers F<sub>1</sub>, F<sub>2</sub> held on them, respectively. Said holders (24), (34) have nearly the same shape. As shown in Figure 3, on their upper surfaces, wall portions (241), (341) are formed a step higher, and they have V-shaped grooves (241a), (341a) for guiding optical fibers F<sub>1</sub> and F<sub>2</sub> in the central portion in the left/right direction. On the left hand side of said wall portion (241) and the right hand side of wall portion (341), supporting table parts (242), (342) for holding the portions of protective film P the concentrically covers the outer periphery of said optical fibers F<sub>1</sub>, F<sub>2</sub> are formed, respectively. On the right hand side of wall portion (241) and on the left hand side of wall portion (341), positioning table portions (243), (343) for optical fibers F<sub>1</sub>, F<sub>2</sub> are formed, respectively. On the upper surfaces of supporting table parts (242), (342), supporting groove (242a) having a concave cross-sectional shape from the left end surface of holder (24) to the left side surface of wall portion (241) and supporting groove (342a) having a concave cross-sectional shape from the right side surface of holder (34) to the right side surface of wall portion (341) are formed, respectively. On the upper surfaces of positioning table parts (243), (343), positioning groove (243a) having a V-shaped cross-section from the right end surface of holder (24) to the right side surface of wall portion (241), and positioning groove (243a) having a V-shaped cross-section from the left end surface of holder (24) to the left side surface of wall portion (341) are formed, respectively. Guide groove (241a), positioning groove (243a) and the central line in the back-and-forth direction of supporting groove (242a) on said holder (24), and guide groove (341a), positioning groove (343a) and the central line in the back-and-forth direction of supporting groove (342a) on said holder (34) are on the same vertical planes, respectively. Also, the bottom portion of guide groove (242a) and the bottom portion of positioning groove (243a) on holder (24) are on the same horizontal line. Also, the bottom portion of guide groove (342a) and the bottom portion of positioning groove (343a) on holder (34) are on the same horizontal line.

Optical fibers F<sub>1</sub> and F<sub>2</sub> have a structure in which on the fused silica glass core as the central portion, fused silica glass clad layer and coating layer are laminated monolithically in a concentric configuration. On the outer periphery of the coating layer, protective coating P, reinforcing knitware, vinyl sheath, etc. are sequentially applied on the outer periphery of the coating layer. When optical fibers F<sub>1</sub> and F<sub>2</sub> are to be spliced, said vinyl sheath, reinforcing knitware, protective coating P are cut off for a prescribed length, and protective coating P and

optical fibers F<sub>1</sub> and F<sub>2</sub> with an appropriate length are peeled out and are guided onto holders (24), (34). The end portion of each protective coating P is set touching the left side surface of wall portion (241) or the right side surface of wall portion (341), while they are fit in supporting grooves (243a), (343a) of supporting table parts (242), (342). Also, optical fibers F<sub>1</sub> and F<sub>2</sub> are fit in guide grooves (241a), (341a) of holders (24), (34) through to positioning grooves (243a), (343a), and they are set with portions of appropriate length of the terminal portions of said optical fibers F<sub>1</sub> and F<sub>2</sub> protruding to the right hand side of positioning groove (243a) and the left hand side of positioning groove (343a), respectively. They are positioned and held with fixtures (25), (26) and (35), (36) on holders (24), (34), respectively.

Said fixtures (25), (26) and (35), (36) are formed in square column shape. Their base end portions are pivoted in a freely rotatable way on the two end sides of horizontal shafts (27), (37) set through mounting parts (241b), (341b) mounted protruding to the rear side of holders (24), (34), respectively. Also, the tips portions are free ends, and set screws (25a), (26a), (35a), (36a) are screwed through them, respectively. Fixtures (25), (35) are rotated from the position shown in Figure 3 to the position having face contact with the surface of the supporting table, and set screws (25a), (35a) are screwed into threaded holes (242b), (342b) formed through supporting table portions (242), (342), so that protective coating P portions of the optical fiber cords are held in supporting grooves (242a), (342a), respectively. Also, said fixtures (26), (36) are rotated from the position shown in Figure 3 to the position of surface contact with the surfaces of positioning parts (243), (343), the tips of set screws (26a), (36a) are attracted with magnets (244), (344) set in front of positioning table portions (243), (343), and optical fibers F<sub>1</sub> and F<sub>2</sub> are pressed and held in positioning grooves (243a), (343a), respectively.

Microscope (4) set above and behind the portion between the facing end surfaces of two holders (24), (34) in left/right side stages (32), (3) is a 2-field of view microscope consisting of two objective lenses (41), (42), and one eyepiece (43). Said objective lens (41) is set above and facing the portion between the facing end surfaces of holders (24), (34), while objective lens (42) is set facing and behind the portion between the facing end surfaces of two holders (24), (34). Also, eyepiece (43) goes across above the portion between the facing end surfaces of two holders (24), (34) at a desired angle and extends to above stage (5) for adjusting the movement of the gas burner on the front side. Said optical fibers F<sub>1</sub> and F<sub>2</sub> to be spliced are caught in the objective lenses (41), (42) from two directions orthogonal to each other, and they are viewed as upper/lower halves in the same field of view of eyepiece (43). (44) represents the lamp of the microscope.

Stage (5) for moving and adjusting the gas burner is set on stationary table (51) on base table (1), and movable table (52) is set such that it can be driven to move back-and-forth as indicated by the arrows in Figures 1 and 2. Another movable table (53) is set on movable table

(52) such that it can move in the left/right direction as indicated by the arrow shown in Figure 2. On said movable table (53), as shown in Figure 2, lift member (54) movable in the vertical direction (the direction indicated by the arrow in Figure 1) is set. Lift member (54) is driven to move by means of movement adjusting screws (51a), (52a), (53a) attached on movable tables (52), (53), and gas burner (58) to be explained later can be adjusted to move to the desired three-dimensional position. As shown in Figure 1, on lift member (54), oxygen bottle (56) and butane gas bottle (57) are mounted by means of supporting frame (55) set on bracket (54a), and said gas bottles (56), (57) are supported with receiving dishes (55c), (55c) on their bottoms, and they have their upper portions connected to pressure-reducing valves (55d), (55d) for flow rate adjustment, respectively.

Protective case (7) is fit in supporting groove (61a) of supporting fixture (61), and the portions of protective coating P of optical fiber cords are fit in supporting grooves (62a), (62a) of supporting fixtures (62), (62), respectively, and they are fixed by means of set screws (61b), (62b), (62b). The two ends of protective case (7) are composed of case main body (71) having groove (71a) with a concave cross-sectional shape and having two ends opened, and lid (72) having a protrusion strip fit in said concave groove. Epoxy resin or other resin adhesive that is in uncured state is injected before use into groove (71a) of case main body (71). After end of the fusion splicing operation, optical fibers F<sub>1</sub> and F<sub>2</sub> are fit together with the protective coating end portions at the two ends in groove (71a) of case main body (71), and the adhesive is applied and cured while lid (72) is closed.

(8) represents a light source as a box, and it has a battery for ignition and an ignition circuit of gas burner (58).

In the following, an explanation will be given regarding the handling sequence for operation of the device of the present invention with the aforementioned constitution. First, left/right side stages (2), (3) are driven to move with movable tables (22), (32) and lift member (33) by means of movement adjusting screws (21a), (31a), (32a) so that two holders (24), (34) are set facing each other with an appropriate distance between them. Also, as shown in Figure 3, fixtures (25), (26), (35), (36) are raised to release the fixed state. On holders (24), (34), two end brackets (32) at the two ends of the two optical fibers with protective coating film P and optical fibers F<sub>1</sub> and F<sub>2</sub> peeled off for an appropriate length by cutting off the desired length of vinyl sheath, reinforcing knitware and protective coating are guided and set. That is, said optical fibers are fit in supporting grooves (242a) (342a) such that the end surfaces of protective coating film P abut against the left side surface of wall portion (241) and the right end surface of wall portion (341), and optical fibers F<sub>1</sub> and F<sub>2</sub> are fit in guide grooves (241a), (341a) through positioning grooves (243a), (343a), with an appropriate length of the end portions protruding to the side of the right end surface of holder (24) and the side of left end surface of holder (34), respectively.

Fixtures (25), (35) are driven to move downward around shafts (27), (37) and are fixed; set screws (25a), (35a) are screwed in threaded holes (242b), (342b) formed through supporting table parts (242), (342), so that the portions of protective coating film P are kept in supporting grooves (242a), (342a); and the lower end surfaces of set screws (25a), (36a) of fixtures (26), (36) are fixed magnetically with the magnetic forces of magnets (244), (344), respectively, so that optical fibers F<sub>1</sub> and F<sub>2</sub> are held in positioning grooves (243a), (343a).

When observation is made through eyepiece (43) of microscope (4) in this state, the end portions of optical fibers F<sub>1</sub> and F<sub>2</sub> are viewed in two directions, that is, from above and behind them with objective lenses (41), (42). Consequently, left/right stages (2), (3) are driven to move by means of moving adjusting screws (21a), (31a), (32a), and alignment is performed so that both images viewed in the 2 directions abut concentrically. After the end of the alignment of said two optical fibers F<sub>1</sub> and F<sub>2</sub>, position adjustment is performed for gas burner (58). Then, gas burner (58) is ignited, and while observing with microscope (4), the operator monitors the fusion upper end of the splicing portion of optical fibers F<sub>1</sub> and F<sub>2</sub>. After completion of fusion, gas burner (58) is turned OFF. At the time when the fusion portion of optical fibers F<sub>1</sub> and F<sub>2</sub> is solidified, fixtures (25), (26), (35), (36) are pulled up, and while a certain tensile force is applied on the optical fiber cords, they are removed from holders (24), (34). In this state, the portions of protective coating film P of the optical fiber cords are fit in supporting fixtures (62), (62), and they are fixed with set screws (62b), (62b). Also, the portion from the fusion splicing portion of optical fibers F<sub>1</sub> and F<sub>2</sub> and the end portions of protective coating film P on the two sides is fit in the groove of case main body (71). An adhesive is injected beforehand in groove (71a), and after oxide films F<sub>1</sub> and F<sub>2</sub> are fit in, lid (72) is closed to have its protruding strip (72a) fit in groove (71a), followed by curing for bonding.

After end of solidification, set screws (61b), (62b), (62b) are loosened, and together with the optical fiber cords, protective case (7) is removed, and the splicing operation is completed.

As explained in the above, for the device of the present invention, as a magnetic force that has its strength depending on the distance is used to hold the optical fibers with respect to the holders, it is possible to make fine adjustment of the supporting strength for the optical fibers. Consequently, there is no excessive squeezing pressure applied on the optical fibers, and it is possible to hold and restrain the optical fibers on the holders with the minimum necessary strength. Also, it is possible to prevent breakage of the optical fibers with a high reliability. This is an excellent effect of the present invention.

### Brief description of the figures

The figures illustrate an application example of the present invention. Figure 1 is an overall oblique view. Figure 2 is a partially cut off plan view of said device. Figure 3 is an enlarged oblique view of the main portion of the holder.

F <sub>1</sub> , F <sub>2</sub>	Optical fiber
4	Microscope
24	Holder
34	Holder
41, 42	Objective lens
58	Gas burner

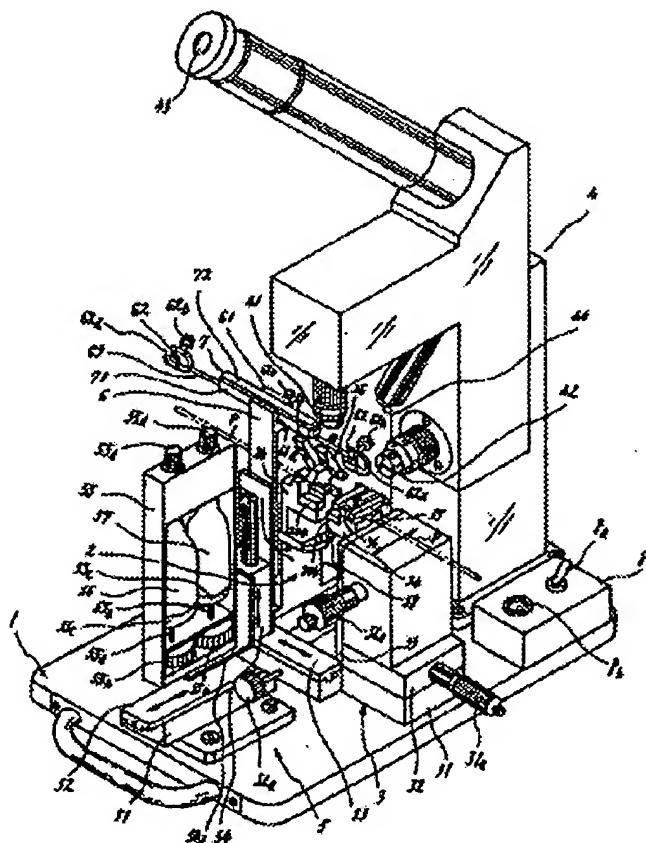


Figure 1

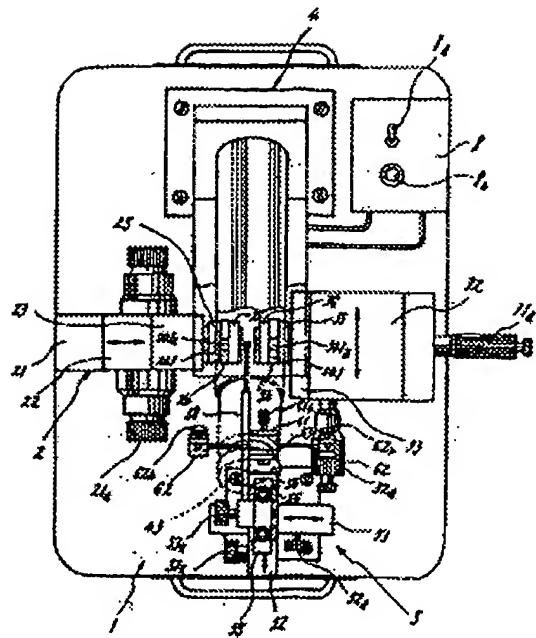


Figure 2

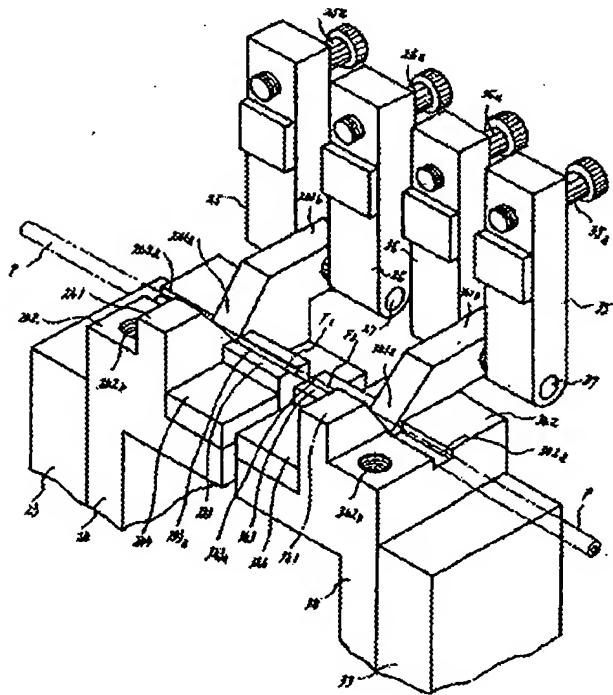


Figure 3